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## BHOPAL: LESSONS LEARNED?

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**BHOPAL: LESSONS LEARNED? George D. Greenly, Jr., Certified Consulting Meteorologist, Lawrence Livermore National Laboratory, Livermore, California 94550 USA**

On December 2, 1984, a series of improbable events culminated in an even more improbable chemical accident that took the lives of more than 2,000 people, injured 200,000 others, and killed approximately 1,800 animals. With the first light of dawn on December 3 came the realization that probable failures in design, maintenance, operation, management, and training, and the lack of an effective emergency preparedness program had thrust the name of Bhopal, India to the top of the list of history's worst industrial disasters. Questions regarding this tragedy beg for an answer. Have we learned from this tragedy? Could it have been avoided through the risk assessment and management tools of Emergency Planning and Response? Are Third World nations more at risk than the industrial nations? Is dose-response worth considering in overall risk management assessments?

Less than two weeks after the Bhopal incident, the U. S. chemical industry was under close governmental scrutiny via Congressional hearings and investigations. Eight months later, the release of methylene chloride and aldicarb oxime at Union Carbide's Institute W. Virginia plant sent 135 people to the hospital, and did not help the post-Bhopal environment in the United States. Legislative amendments to the Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("Superfund"), patterned after the European Communities' Seveso directive, were introduced one month later. The U. S. chemical industry, in the wake of Bhopal, has taken steps to reduce stockpiles of dangerous chemicals, installed detection equipment, and in a very bold move, the Chemical Manufacturer's Association (CMA) has launched a community Awareness & Emergency Response (CAER) program. It is designed to encourage local chemical companies to re-examine their emergency response plans in order to determine how they fit the local community's plans. In cases where no plan exists, CAER will assist in developing one. Such is the legacy of the Bhopal tragedy in the United States. But, are increased awareness programs and lists of toxic substances sufficient in and of themselves in the U. S. and especially in the developing nations? It is ironic that the technology used to help feed millions and save lives can also lead to disaster and kill thousands as in the Bhopal incident. The technology transfer to the developing nations creates opportunities for the countries and for the populace. Unfortunately, the rising expectations cause overcrowding which leads to disaster in accidents like Bhopal and Ixhuatepec, Mexico. Even though many developing countries have begun to strengthen their safety and environmental regulations, there is no coordinated plan of action for emergency planning technology transfer to the developing nations. This is especially significant since one of the lessons of Bhopal is that emergency planning and response may not be as integral a part of risk assessment and management programs as it should be. One would have to be extremely naive to believe that there are not other Bhopal-like accidents waiting to happen. While efficient emergency planning and response programs will not prevent accidents like Bhopal, they *do* have the ability to mitigate the consequences of those low probability events when they occur.

Responsible risk assessment and management must consider the hazard beyond the chemical plant boundary. This is an integral part of the controlling activity of risk (liability) management that requires an emergency response capability to supplement the other

capabilities—remedial action, environmental cleanup, and corrective action. Prudent risk management plans for the maximum credible event *regardless* of a low probability of occurrence. Lessons learned from real accident experience in the nuclear industry are directly applicable to the worldwide chemical industry, and are a key factor in effective emergency planning.

Following the Three Mile Island nuclear power plant accident, the Federal Radiological Emergency Response Plan (FRERP) was developed. The U. S. Department of Energy's Atmospheric Release Advisory Capability (ARAC) is a key part of the U. S. nuclear emergency response force. ARAC provides high quality atmospheric transport and diffusion calculation assessments to the U. S. crisis managers dealing with actual or potential releases of radiotoxic material. ARAC is also active in the international arena through the International Atomic Energy Agency (IAEA) and cooperative arrangements with five nations. Some of the basic concepts of ARAC's approach to emergency planning and response are being emulated by at least two of these nations.

Advancements in computer technology, telecommunications, and three-dimensional atmospheric dispersion modeling make the concept of an international resource for all emergency planning and response very viable. The technology nucleus exists for an International Toxic Release Advisory Center (ITRAC) under the aegis of the United Nations (UN). ITRAC would focus its efforts on the development of, technology transfer to, and training of National Atmospheric Release Advisory Centers (NARAC) in member nations.

The risk assessment lesson learned from the Bhopal tragedy is both simple and complex. Practical planning for toxic material releases must start with an understanding of what the risks and possible consequences are. Additionally, plans must be formulated to ensure immediate decisive actions tailored to site specific scenarios, and the possible impacts projected on both the plant and surrounding communities. Most importantly, the planning process must include the communities that could be affected. Such planning will ultimately provide significant financial savings and provide for good public relations, and this makes good business sense in both developed and developing countries. Paraphrasing the adage "a penny saved is a penny earned," a penny spent on emergency preparedness is dollars earned through public awareness. The complex aspect of these simple concepts is overcoming human inertia, i.e., overcoming the "it can't happen here" syndrome in both government and private industry. A world center of excellence (ITRAC), acting as a center for education, research, and development in the area of emergency planning and response, will be the conduit for needed technology transfer to national centers of excellence in emergency planning and response. These national emergency planning and response centers (NARACS), managed by private industry for governments, will be catalysts to action in formulating effective plans involving potentially affected communities and plant management. The ITRAC/NARAC proposal is a simple concept involving complex ideas to solve the simple problem of being prepared for the Bhopal-like emergency which, as experience has demonstrated, will have complex consequences for the unprepared.

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